Firefly gene lights up plants

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A team of scientists at the University of California, San Diego has introduced the gene that lights up fireflies into tobacco plants to produce plants that glow in the dark.

"This is the first time anyone has taken a gene that codes for light production and transferred it into the genetic material of a complex multi-cellular organism," UCSD molecular geneticist Donald R. Helinski, one of the primary investigators, said in a recent interview.

The firefly gene promises to be an "extremely valuable" research tool for tracing gene expression within living systems, for learning more about plant development, and for genetic engineering in plants.

The biotechnology and agriculture industries--one intent on developing new products, such as pharmaceuticals, and the other set on developing more productive, more nutritious, disease resistant crops--have shown an active interest in using this new technology.

Helinski, plant biologist Stephen H. Howell and biochemist Marlene Deluca described the procedure in the Nov. 14 issue of Science. Collaborating on the research were UCSD post-doctoral fellow David W. Ow and graduate students Keith V. Wood and Jeffrey R. de Wet.

Using recombinant DNA technology, the researchers have introduced the firefly's "lantern," the enzyme luciferase, into the plant's DNA. The work was done in strict containment.

The luciferase gene offers basic researchers a noninvasive and non-destructive way to study gene expression, the turning on and off of genes, in plant and--before too long--in animal cells.

To measure gene expression, the firefly gene must be hooked up-to the plant gene that scientists want to study. Then, when the plant gene is actively expressing itself, such as when a new leaf forms, the firefly gene simply lights up. The light can be detected and measured by a number of devices.

"To understand how genes are turned on and off during the course of development and in what context is very important," Howell commented recently. "The tissues in our own bodies become different from one another because certain constellations of genes are turned on and off in specific parts of the body. The same holds true for plants."

Howell and his colleagues plan to supply university laboratories and biotechnology firms with the luciferase gene. The companies construct and manipulate genes to create their new products. The firefly beacon is expected to provide them with the rapid, efficient, and sensitive means they need to learn how well their "designer" genes work.

The versatile gene also may advance genetic engineering as a genetic marker, permitting scientists to trace a targeted gene through a number of generations to follow its inheritance characteristics. For example, a plant breeder could get important information on how to help a plant bolster its resistance to disease by linking the firefly gene to the gene for disease resistance and tracking it through subsequent generations.

"It's really a remarkable chain of events that enabled us to transfer DNA containing the firefly gene into plant cells. It's not unusual in science to build something on top of the work of others. We depended on the tremendous amount of

information that has been developed by other molecular geneticists about the way in which different organisms interact to bring this phenomenal transfer about," Howell said.

The UCSD researchers performed their technological feat by fusing the luciferase gene to a plant gene and inserting the new composite gene into a plasmid, a circle of DNA in bacteria. Using recombinant DNA procedures, they transferred the modified piece of DNA back into bacteria, which in turn injected it into plant tissues growing in the laboratory. Before long, the plant cells had incorporated the DNA into their own genetic information.

From the individual cells that contain the luciferase gene, the scientists grew entire plants. From the seeds of these regenerated plants, they have grown a nursery full of plants containing the firefly gene.

"These plants produce light when their luciferase is combined with adenosine triphosphate (ATP, a cell's power pack) and oxygen, which are present in the plant, and an organic molecule called luciferin, which must be added. Luciferase acts as catalyst, converting the chemical energy into light," Deluca explained.

The light can be detected and measured by simple X-ray film exposure or by more elaborate devices such as luminometers or image-intensifying video equipment. It is possible to see the plant's luminescence with the naked eye, but it is low-level and must be observed in a darkened room.

Tobacco plants were used for the experiments because they are a model plant system and are relatively easy to work with. UCSD researchers have also begun to explore the use of firefly luciferase in monkey and mouse cells growing in the laboratory.

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